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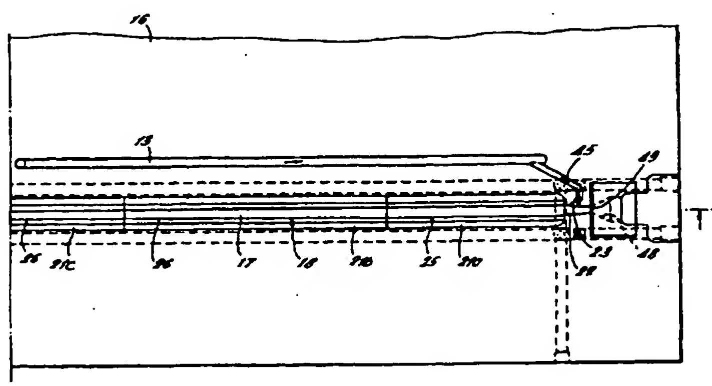

(57) Abstract

The invention provides a method of moulding an elongate member (20) in which an amount of fibre filled molten plastics material is introduced through an injection aperture (23) into a mould space (17) having a longitudinal axis and including a peripheral wall surface (18) which conforms to the corresponding external configuration of the elongate member. Pressurized fluid is introduced into the plastics material to form a hollow cavity (29) within the plastics material in the mould space. The mould space has an axially extending chamber (22) upstream of the peripheral wall surface. The injection aperture projects the plastics material into the chamber at an obtuse angle to the axis of the mould space in the direction of plastics flow whereby the plastics material is introduced through the injection aperture without jetting and the fibres remain substantially unbroken and oriented substantially longitudinally of the elongate member. The pressurized fluid is introduced into the chamber through a separate opening (49) which is directed at least substantially along the axis of the mould space in the direction of plastics flow. The invention also provides apparatus for carrying out the method defined above. One use is a golf club shaft (44) comprising an elongate member or blank (42) moulded as above, and wrapping material (32 to 36) around at least part of its length including the end of the blank forming a handle portion (39).

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METHOD AND APPARATUS FOR MOULDING ELONGATE MEMBERS AND IN PARTICULAR GOLF CLUB SHAFTS

The invention relates to a method and apparatus for moulding elongate members. More particularly but not exclusively, the invention relates to moulding a core member for a golf club shaft or other rod-like member, e.g. a snooker cue, fishing rod or antenna.

The invention further relates to golf club shafts and golf clubs made therefrom, or similarly other rod like members such as snooker cues, fishing rods and antennæ.

Golf club shafts require to combine strength and flexibility. It is known to manufacture golf club shafts from composite material. Currently such shafts are formed by wrapping a number of layers of fibre reinforced, curable material around a steel core, curing the material and then removing the core after curing.

It has been proposed in GB-A-2276859 to form the core member by gas-assisted injection moulding and for the core member to remain in place in the finished golf club shaft. This proposal allows for a substantial reduction, perhaps from as many as 20 to just five layers of wrapping. The specification of GB-A-2276859 discloses suitable wrapping material.

Introducing plastics material into a mould space longitudinally of plastics flow is undesirable because it results in jetting. It is also found that introducing composite plastics material transversely of the direction of flow results in the fibres becoming disoriented and breaking, both of which lead to a reduction of strength in the resultant moulding.

According to the invention there is provided a method of moulding an elongate member in which an

amount of fibre filled molten plastics material is introduced through an injection aperture into a mould space having a longitudinal axis and including a peripheral wall surface which conforms to the corresponding external configuration of the elongate member, and pressurised fluid is introduced into the plastics material to form a hollow cavity within the plastics material in the mould space, the cavity extending longitudinally of the resultant moulding, wherein the mould space has an axially extending chamber upstream of the peripheral wall surface, the injection aperture projects the plastics material into the chamber at an obtuse angle to the axis of the mould space in the direction of plastics flow whereby the plastics material is introduced through the injection aperture without jetting and the fibres remain substantially unbroken and oriented substantially longitudinally of the elongate member, and the pressurised fluid is introduced into the chamber through a separate opening therein which opening is directed at least substantially along the axis of the mould space in the direction of plastic flow.

Preferably the wall of the chamber is divergent relative to the axis of the mould space in the direction of plastics flow.

In one embodiment, a ring injection aperture extends around the chamber to direct the molten plastics material into the chamber at the required obtuse angle to the axis of the mould space from around the periphery of the chamber.

The pressurised fluid is preferably a gas, e.g. nitrogen.

It is also preferred that after the moulding has been removed from the mould, the end portion which was

moulded upstream of the peripheral wall surface of the mould space, is cut off or otherwise removed.

Preferably the fibres have a length within the range of 2mm and 15mm, and may typically have a length of about 12mm.

In one embodiment of the invention, during the step of introducing the pressurised fluid, a portion of the plastics material in the mould space is pushed by the pressurised fluid into an extension overflow of the mould space downstream of the peripheral wall surface, thereby extending the gas flow within the plastics material in the mould space towards and may be into the extension overflow. The overflow may comprise part of the mould space at its downstream end, or may comprise a chamber separated from the mould space by a gate, which may be closable. The overflow chamber may be variable in volume.

The method preferably includes the step of moulding an elongate member which is hollow over at least a major proportion of its length, and said hollow portion preferably has a constant wall thickness. If desired, the elongate member may have a non-constant wall configuration including a sharp change of external shape at one or more positions along its length. For example, the elongate member may have a localised area or areas of thickening or thinning.

Said peripheral wall surface is preferably tapered inwardly of the mould space, over at least a portion of its length, in the direction of plastics flow. Likewise, the peripheral wall surface may include a sharp change of shape either outwardly or inwardly at one or more positions along its length.

Preferably the method includes the step of applying wrapping material to the surface of the

elongate member around at least part of its length. The wrapping material may be trapezoidal shaped sheet or tape.

In one embodiment, at least one layer of wrapping material is disposed within the mould space whereby it becomes at least partially impregnated with plastics material during the plastics injection stage of the moulding cycle. The wrapping material may be a woven stocking material.

The invention also provides apparatus for moulding an elongate member by a method as defined above, the apparatus comprising a mould defining a mould space having a longitudinal axis and including a peripheral wall surface which conforms to the corresponding external configuration of the elongate member, means for introducing an amount of fibre filled molten plastics material through an injection aperture into the mould space, and means for introducing pressurised fluid into the plastics material to form a hollow cavity within the plastics material in the mould space, the cavity extending longitudinally of the resultant moulding, wherein the mould space has an axially extending chamber upstream of the peripheral wall surface, the injection aperture being open to the chamber and directed to project the plastics material into the chamber at an obtuse angle to the axis of the mould space in the direction of plastics flow, and the means for introducing pressurised fluid into the plastics material are arranged to introduce the fluid through a separate opening in the chamber, which opening is directed at least substantially along the axis of the mould space in the direction of plastics flow.

The invention further provides an elongate member produced by a method or apparatus as defined above.

Preferably the elongate member is a blank for a golf club shaft, snooker cue, fishing rod, antenna or like member.

In the case of a golf club shaft, the blank preferably has wrapping material, e.g. five layers, around at least part of its length including the end of the blank forming the handle portion. Over one or more parts of its length, the blank may have a different number of layers or thickness of wrapping than at other parts. The blank may be wound with strip or filament wrapping material.

The invention still further provides a golf club comprising a golf club shaft as defined above and a golf club head attached thereto.

By way of example, a specific embodiment in accordance with the invention will be described with reference to the accompanying diagrammatic drawings in which:-

Figure 1 shows an arrangement for moulding an elongate member by gas-assisted injection moulding;

Figures 2a and 2b are a split plan view of the lower half of the mould tool of the arrangement of Figure 1;

Figure 3 is a section along line 3-3 in Figure 2;

Figure 4 is an elevation of the resultant moulding before being trimmed to length;

Figure 5 is an enlarged longitudinal section of the moulding of Figure 4, illustrating the portion to form an elongate core member or blank for the shaft of a golf club, and illustrating the various changes of cross-section along its length;

Figure 6 shows the elongate member formed from the moulding of Figures 4 and 5 wrapped and trimmed to length to form a golf club shaft;

Figure 7 is a graph showing the longitudinal

variation of diameter of the golf club shaft of Figure 6;

Figure 8 illustrates a golf club having the shaft of Figure 6 and a golf club head attached thereto;

Figure 9 illustrates another embodiment of moulding in which the overflow extension is part of the mould space at its downstream end;

Figures 10 to 12 are enlarged detail views, in section, showing variants of shape of the moulding of Figures 4 and 5;

Figure 13 illustrates an embodiment in which a layer of wrapping material is applied within the mould space during the moulding cycle;

Figure 14 shows an alternative ring injection aperture for the plastics material at the upstream end of the mould space of Figure 2a; and

Figure 15 illustrates an embodiment of a mould tool having a hot runner system.

This example concerns the moulding of an elongate core member or blank for the shaft of a golf club by employing gas-assisted injection moulding. The same technique may be applied for moulding the blank of other elongate members, for example, a snooker cue, fishing rod or antenna.

With reference to Figure 1, there is shown an arrangement for gas-assisted injection moulding which operates in a manner substantially similar to the process described in European Patent Specification No.0283207. A screw ram 10 is provided for introducing a stream of fibre filled molten plastics material 11 through a nozzle assembly 65 and a sprue 12 into a runner system 13 of a mould tool 14. The nozzle assembly 65 is provided with a shut-off slide valve 66 actuated by a bell-crank lever 67 and a link 68 connected to a hydraulic cylinder 69. The valve 66

is shown in its closed position in Figure 1 at the end of the moulding cycle. The closed valve prevents any return movement of the plastics material to the barrel of the screw ram 10.

The plastics material used in this embodiment is a fibre filled polyamide but other fibre filled thermoplastics materials may be employed. The plastics material may include further constituents, e.g. impact modifiers. The fibres also have a typical length of 12mm, but are preferably within the range of 2mm and 15mm in length.

The mould tool is formed of upper and lower halves 15, 16 which can be relatively opened and closed. The mould halves 15, 16 define an elongate mould space 17 having a longitudinal axis and including a peripheral wall surface 18 which conforms to the corresponding external configuration 19 of the elongate member 42 to be moulded. The mould space 17 also extends a short distance at either end (see Figures 2 and 3) for the purpose described below.

For convenience, the peripheral wall surface 18 is formed by a series of five insert members 21a to 21e arranged end to end within the mould tool and combining to provide the peripheral wall surface 18 of the mould space 17. The right hand end insert member 21a as viewed in Figures 2 and 3 has a wall surface 25 which is parallel to the longitudinal axis of the mould space 17, whilst successive insert members 21b to 21e from right to left have a wall surface 26 which is inwardly tapered relative to the longitudinal axis of the mould space. The left hand end insert member 21e also has at least a portion 47 of the wall surface at its outer end which is parallel to the longitudinal axis of the mould space.

At the right hand end or upstream end of the

mould space 17, there is a short extension or chamber 22 into which the runner system 13 feeds the molten plastics material 11. The runner system 13 includes, at its part preceding the chamber 22, a short passage 45 (Figure 2b) of constant diameter along its length which defines a partial return sweep or bend extending to an injection aperture 23 open to the chamber. The injection aperture 23 is angled relative to the longitudinal axis of the mould space 17 to project the plastics material into the chamber 22 at an obtuse angle to the axis of the mould space in the direction of plastics flow, i.e. from right to left as illustrated.

A nozzle 24 of the type known from EP-A-0283207 or EP-A-0644821 is provided for separately introducing pressurised gas, e.g. nitrogen, into the plastics material within the mould space 17 through a valve port opening 49 in the outer end of the chamber 22 to form a gas filled cavity 29 (see Figure 5) in the plastics material. The valve port opening 49, which is separate from the injection aperture 23 for introducing the plastics material 11, is directed at least substantially along the axis of the mould space 17. The same gas injection nozzle 24, when withdrawn, allows the gas filled cavity to be vented through the valve port opening 49 to atmosphere before the mould tool is opened. The gas is thereby injected under pressure longitudinally of the mould space 17 in the direction of plastics flow. Alternatively, the nozzle 24 may be adapted for introducing an alternative fluid, e.g. a liquid, under pressure, but pressurised gas is preferred.

More particularly, a piston and cylinder 50 is controlled via a solenoid operated valve 51 by control means (not shown) to move the nozzle 24 between

forward (as shown in Figure 1) and withdrawn positions. In the forward position, the nozzle 24 is in sealing engagement with a conical valve seat 48 of the valve port opening 49 directly into the mould space 17. In the end of the nozzle 24 is a non-return valve, or a valve member which is opened by the pressure of the gas for introducing the gas to form the cavity 29 and closed by spring pressure before the nozzle is withdrawn to vent the cavity. Pressurised gas is supplied to the nozzle 24 from a chamber 53 of a piston and cylinder 54, 55, the chamber holding a measured amount of the gas which it is required to introduce into the plastics material. The chamber 53 is connected to the nozzle 24 via a solenoid operated valve 56 and to a gas supply (not shown) via a non-return valve 57 and a pressure regulator 58. Downstream of the valve 56, the connection has a feed to waste via a solenoid operated valve 59.

At the downstream end of the mould space 17 there is another extension which in this embodiment comprises a gate 27 leading to an overflow chamber 28 into which plastics material is forced by the pressurised gas. The chamber 28 acts to extend the gas flow to a position at least close to the downstream end or narrowest part of the elongate member, and to provide the resultant moulding 20 (Figure 4) with a wall 43 of substantially constant thickness (see Figure 5) throughout the length of the moulding defined by the peripheral wall surface 18.

Figures 4 and 5 show the resultant moulding 20 in which the hollow cavity 29 formed by the introduction of pressurised gas extends from the right hand end to a position adjacent to the left hand end as illustrated. Both end portions 30, 31 are subsequently cut off or otherwise trimmed in length along or within

lines 40, 41 to form the required elongate member 42 (Figure 5). In another embodiment, the cavity 29 may initially extend further into the overflow chamber 28.

The molten plastics material is fibre filled with fibres which, in this embodiment have a length of about 12mm. It is important that the fibres are oriented substantially parallel to the longitudinal axis of the mould space and remain substantially unbroken during the moulding process. This also applies even if the fibres are at the shorter end of the range of 2mm to 15mm. It is for these reasons that the injection aperture 23 is directed to project the fibre filled plastics material at an obtuse angle to the longitudinal axis of the mould space 17 in the direction of plastics flow.

In use, the screw ram 10 is operated to introduce an amount of fibre filled molten plastics material into the chamber 22 of the mould space 17 through the sprue 12, runner system 13, passage 45 and injection aperture 23, the amount being sufficient to form the resultant moulding, but not to fill the mould space. The direction in which the plastics material is projected into the chamber 22 is important to avoid jetting and also, as explained above, to retain the fibres oriented substantially longitudinally of the mould space and unbroken. Otherwise, the strength purported to the plastics material by the fibres in the resultant moulding is materially reduced.

Valve 56 is actuated to introduce pressurised gas separately from the plastics material, into the chamber 22 of the mould space 17 through the nozzle 24 disposed at the outer end of chamber 22, the gas thereby being directed longitudinally of the mould space in the direction of plastics flow. The pressure of the gas is sufficient that the gas enters the

plastics material and creates a gas filled cavity therein. In known manner, the gas causes the plastics material to continue flowing to fill the mould space and thereafter to fill the overflow chamber 28 at the downstream or left hand end of the mould space, as illustrated, relative to the separate input positions of the plastics material and the pressurised gas. The provision of the overflow extension acts to extend the gas flow to a position at least close to the gate 27 leading to the chamber 28 and to achieve a substantially constant wall thickness 43 of the hollow portion of the elongate member 42.

Gas pressure is maintained within the gas filled cavity 29 until the plastics material has cooled sufficiently to maintain its conformity with the internal surface of the mould space. The nozzle 24 is withdrawn to allow the gas from the hollow cavity 29 within the plastics material to vent through the valve port opening 49 to atmosphere. The mould tool is then opened and the moulding 20 removed from the lower half 10 of the mould tool. In practice, it is found that generally as the moulding 20 is removed from the mould tool, the portion of plastics material which has flowed into the overflow extension chamber 28 breaks off at the gate 27 leading thereto. Both end portions 30, 31 of the moulding 20 are later cut off or otherwise trimmed along or within lines 40, 41 (Figure 5) as described below.

First, for transforming the moulding 20 into a golf club shaft 44, layers of conventional wrapping material are wrapped around the moulding. In this embodiment, the core member or blank 42 has five standard wraps 32 to 36, each wrapping extending along the full length of the core member (Figure 6). The wrapping material may be in the form of strip or a

filament which is wound around the core member to provide the thickness of wrapping required. In this embodiment, the wrapping is of constant thickness along the full length of the core member, but the thickness may be varied by providing more or less layers. Also the thickness may be varied locally, for example, made thicker by applying more layers of wrapping along a selected portion or portions of the core member. Likewise, any one or more of the layers of wrapping may extend over only part of the length of the core member between the lines 40, 41.

After wrapping the core member 42, the end portions 30, 30 are trimmed off along or within lines 40, 41 (Figure 5) to provide the golf club shaft of Figure 6.

In Figure 7, there is shown the variation of diameter of the wrapped elongate core member 42, of this embodiment, along its length. At the thinner end, the elongate member has a constant diameter for a length of about four inches, which may be cut shorter if required, and on which is subsequently fitted the conventional bushing 37 of a golf club head 38. Thereby, as shown in Figure 8, a head 38 of a golf club is attached to the shaft 44 in known manner. At the other end, additional wrapping material or other means may be applied to provide the desired handle portion 39.

In this embodiment, the attachment bushing 37 for the golf club head has a constant internal diameter matching that of the respective end portion of the shaft 44. Alternatively, the attachment bushing may have a tapered bore, in which case the end portion of the shaft has a matching configuration for fitting therein.

The fact that during the moulding of the elongate

member 42, the fibres are maintained oriented longitudinally of the plastics material, and importantly are not broken during entry into the mould space, gives the elongate member 40 greater combined strength and flexibility than has been provided hitherto. The shaft 44 also combines low weight content with high strength.

During wrapping of the moulding 20, the moulding is preferably supported at its ends for the wrapping material to be wound thereon. The moulding is also generally rotated during the wrapping operation. It has thus been found that it is advantageous for the plastics material to be solid at its extreme thin end so that it can be more easily supported. For this to be achieved, the overflow extension chamber at the downstream end of the mould space is formed by insert 21f in part 60 of the mould space 17 (Figure 9) rather than a separate chamber 28 separated from the mould space 17 by a gate 27 as shown in Figures 1 to 3. The effect of this arrangement is that the resultant moulding 70 has a longer solid end section 71 at its thinner end, which is easier to support during wrapping. After wrapping, the end portions are cut off or otherwise removed as before.

In an alternative embodiment, the wrapping device is rotated, whilst the blank is held stationary.

Preferably, the golf club shaft so formed is hollow throughout its full length, or if it has a solid end portion, the solid part is housed within the bushing 37 of the club head 38 so that it protects the transition point between the solid section and the hollow section which could otherwise adversely affect the strength of the shaft at that point.

In addition, the thickness of the elongate member affects its stiffness or flexibility which is an

important factor in the manufacture of a golf club shaft. As mentioned above, the thickness of the shaft either over its full length or locally can be varied by the extent to which the core member is wrapped. Alternatively, the thickness may be varied by locally controlling the thickness of the core member or blank during moulding.

Figures 10 to 12 show variants of shape of an elongate core member or blank for a golf club shaft having a localised sharp change of shape at one or more positions along its length to give greater stiffness and flexibility or other characteristic where it is required most.

For example, Figure 10 shows one variant in which the peripheral wall surface of the mould space provides the resultant moulding 72 with a sharp change of shape in an outward direction giving the effect of a bubble shape 73.

In Figure 11, the peripheral wall surface provides a wave shape of one or more waves 74 like a bellows.

Figure 12 shows a further variant in which there is a sharp thinning or necking effect 75.

In each case, the resultant moulding is then wrapped as before and trimmed to length to form the final golf club shaft. Finally, a golf club head 38 is attached to the shaft.

Alternatively, one or more areas of increased thickness may be achieved by building up the thickness of wrapping. In this way, a particular wrapping material, e.g. boron, having a high strength characteristic, can be used locally to give a beneficial effect, whereas the material would be too expensive to use over the full length of the shaft.

It has been mentioned that the layers of wrapping

material may be in the form of a strip or filament. Filament material may be a single strand filament or a multiple strand strip or tape which is woven or plaited. In one embodiment, trapezoidal shaped sheet or tape is wrapped around the moulded core member or blank 42 using a conventional technique known as table wrapping.

Alternatively or additionally, wrapping material in the form of a woven stocking may be employed. One method of application is to apply a tube or layer of the stocking material 80 in the mould (Figure 13) so that during the plastics injection stage of the moulding cycle, the stocking material becomes partially or wholly impregnated with plastics material and forms part of the skin of the resultant moulded blank. The stocking material 80 may be disposed within the mould space 17 before it is closed. Alternatively, stocking material in tube form may be blown or otherwise introduced into the mould space 17 after the mould halves 15, 16 are closed together.

In another embodiment, the stocking material is applied to the moulded blank 42 after it is removed from the mould. In this case, the woven stocking material is drawn over the blank and bonded thereto by applying heat. The application of heat causes the stocking material to contract to form a tight fit onto and bond to the softened surface of the blank with or without a degree of impregnation of the plastics material into the stocking material.

In either embodiment, the stocking material may form the outer finished surface of the golf club shaft and extend over all or part of the length of the moulded core. Alternatively, the surface formed may be overwrapped in a manner described earlier over part or all of its length.

When wrapping a blank with layers of wrapping material, it is important that there results a physical bond and preferably a chemical bond between adjacent layers, and between the innermost layer and the blank itself. For this purpose, the wrapping material is tightly applied and subsequently heated in an oven. Epoxy in the wrapping material commingles with the softened surface of the blank and is adhered thereto.

It is also important that no air bubbles should remain between layers of wrapping material or between the wrapping material and the surface of the blank. Any air bubbles are driven out by the step of heating the wrapping material to shrink bond the wrapping material onto the blank.

In another embodiment, a blank wrapped with layers of wrapping material is inserted longitudinally into a tight fitting female mould and heated. The mould has the same taper as the shaft and the combination of forcing the wrapped layers therein and the application of heat causes the layers of wrapping material to be compressed relative to each other and onto the inner blank, thereby achieving the required bond and absence of air bubbles. If desired, additional epoxy material may be added during the step of forcing the wrapped blank longitudinally into the mould, the epoxy becoming impregnated into the layers and assisting to bond the layers of wrapping together and onto the plastics blank.

Instead of epoxy, thermoplastic materials may be used, e.g. nylon or polyester. In this case, the nylon or polyester melting on the application of heat assists to bond the wrapping material onto the plastics blank.

With reference to Figure 2a, there is shown a gate 27 leading to an overflow chamber 28 at the downstream end of the mould space 17 into which plastics material is forced by the pressurised gas. If desired, the gate 27 is closable. This allows the overflow chamber not to be used, or to be opened at a specified stage in the moulding cycle. For example, the gate may be closed initially at the start of plastic injection, and then opened at the end of plastic injection or during gas injection depending on the conditions required. In another embodiment, the gate 27 may be adjustable allowing the gate to be opened to a different extent depending on the polymer being moulded.

Alternatively or additionally, the overflow chamber 28 is variable in volume. This may be achieved by a chamber which is expandable either by control means at a selected time in the moulding cycle or by pressure of the plastics material as it flows into or fills the vacant space in the overflow chamber. In a particular embodiment, the overflow chamber 28 contains a piston which is withdrawn to increase the volume of the chamber. At the beginning of the moulding cycle and during the plastic injection stage, the piston is advanced and the effective volume of the chamber is zero. Means may be provided to withdraw the piston at a specified time in the cycle, for example, either at the beginning of gas injection or during the gas injection stage. Alternatively, the piston may be spring loaded or hydraulically loaded so that the piston is pushed back by the gas pressure acting on the plastics material during the gas injection stage. A portion of the plastics material thereby flows into the volume of the chamber created by the piston as it withdraws against the spring or hydraulic pressure.

At the upstream end of the mould space 17 (Figure 2b), the runner system 13 and passage 45 feeds plastics material through aperture 23 into the extension or chamber 22. In an alternative embodiment illustrated in Figure 14, passage 45 feeds plastics material to a ring injection aperture 81. The ring aperture 81 comprises an annular opening which extends around the periphery of the chamber 22, and is directed into the mould space 17 at the same angle to the axis of the mould space as the aperture 23 of Figure 2b. Plastics material thus fills the ring 81 and enters the chamber 22 at the required obtuse angle from around its whole periphery. This arrangement can create a more even flow of plastics material at the upstream end of its flow within the mould space 17.

In a further embodiment, the runner system 13 is a hot runner system in which the plastics material is maintained molten throughout the moulding cycle and does not become waste material between cycles. To achieve this, a valve 82 is provided in the passage 45 at or close to its end nearest the aperture 23 or 81 (Figure 15). The valve 82 is open during the plastics injection stage and then closed. When closed, the valve 82 prevents the gas flowing up the passage 45 past the valve 82 and thereby entering the hot runner system, both during the gas injection stage or whilst gas pressure is maintained within the mould space 17. The closed valve 82 also prevents the hot plastics material drooling from the passage 45 between moulding cycles.

CLAIMS

1. A method of moulding an elongate member in which an amount of fibre filled molten plastics material is introduced through an injection aperture into a mould space having a longitudinal axis and including a peripheral wall surface which conforms to the corresponding external configuration of the elongate member, and pressurised fluid is introduced into the plastics material to form a hollow cavity within the plastics material in the mould space, the cavity extending longitudinally of the resultant moulding, wherein the mould space has an axially extending chamber upstream of the peripheral wall surface, the injection aperture projects the plastics material into the chamber at an obtuse angle to the axis of the mould space in the direction of plastics flow whereby the plastics material is introduced through the injection aperture without jetting and the fibres remain substantially unbroken and oriented substantially longitudinally of the elongate member, and the pressurised fluid is introduced into the chamber through a separate opening therein which opening is directed at least substantially along the axis of the mould space in the direction of plastics flow.

2. A method as claimed in Claim 1, wherein the wall of the chamber is divergent relative to the axis of the mould space in the direction of plastics flow.

3. A method as claimed in Claim 1 or Claim 2, wherein a ring injection aperture extends around the chamber to direct the molten plastics material into the chamber at the required obtuse angle to the axis

of the mould space from around the periphery of the chamber.

4. A method as claimed in an one of the preceding claims, wherein the pressurised fluid is a gas, e.g. nitrogen.

5. A method as claimed in any one of the preceding claims, wherein after the moulding has been removed from the mould, the end portion which was moulded upstream of the peripheral wall surface of the mould space, is cut off or otherwise removed.

6. A method as claimed in any one of the preceding claims, wherein the fibres have a length within the range of 2mm to 15mm.

7. A method as claimed in any one of the preceding claims, wherein during the step of introducing the pressurised fluid, a portion of the plastics material in the mould space is pushed by the pressurised fluid into an extension overflow of the mould space downstream of the peripheral wall surface, thereby extending the gas flow within the plastics material in the mould space towards and may be into the extension overflow.

8. A method as claimed in Claim 7, wherein the overflow comprises part of the mould space at its downstream end.

9. A method as claimed in any one of the preceding claims, including the step of moulding an elongate member which is hollow over at least a major proportion of its length, and said hollow portion has

a constant wall thickness over its full length.

10. A method as claimed in any one of the preceding claims, wherein said peripheral wall surface is tapered inwardly of the mould space, over at least a portion of its length, in the direction of plastics flow.

11. A method as claimed in any one of the preceding claims, wherein said peripheral wall surface includes a sharp change of shape either outwardly or inwardly at one or more positions along its length.

12. A method as claimed in any one of the preceding claims, including the step of applying wrapping material to the surface of the elongate member around at least part of its length.

13. A method as claimed in Claim 12, wherein the wrapping material is a trapezoidal shaped sheet or tape.

14. A method as claimed in Claim 12, wherein at least one layer of wrapping material is disposed within the mould space whereby it becomes at least partially impregnated with plastics material during the plastics injection stage of the moulding cycle.

15. A method as claimed in Claim 12, wherein one or more layers of wrapping material are subsequently applied to the moulded elongate member in a mould whilst applying heat, whereby adjacent layers become bonded together and onto the elongate member.

16. A method as claimed in Claim 14 or Claim 15,

wherein the wrapping material is a woven stocking material.

17. Apparatus for moulding an elongate member by a method as claimed in Claim 1, the apparatus comprising a mould defining a mould space having a longitudinal axis and including a peripheral wall surface which conforms to the corresponding external configuration of the elongate member, means for introducing an amount of fibre filled molten plastics material through an injection aperture into the mould space, and means for introducing pressurised fluid into the plastics material to form a hollow cavity within the plastics material in the mould space, the cavity extending longitudinally of the resultant moulding, wherein the mould space has an axially extending chamber upstream of the peripheral wall surface, the injection aperture being open to the chamber and directed to project the plastics material into the chamber at an obtuse angle to the axis of the mould space in the direction of plastics flow, and the means for introducing pressurised fluid into the plastics material are arranged to introduce the fluid through a separate opening in the chamber, which opening is directed at least substantially along the axis of the mould space in the direction of plastics flow.

18. Apparatus as claimed in Claim 17, wherein the wall of the chamber is divergent relative to the axis of the mould space in the direction of plastics flow.

19. Apparatus as claimed in Claim 17 or Claim 18, wherein the mould has a runner system for the plastics material including a passage of constant diameter

defining a partial return sweep or bend leading to the injection aperture into said chamber of the mould space.

20. Apparatus as claimed in Claim 19, wherein the runner system is a hot runner system including a shut-off valve adjacent the injection aperture.

21. Apparatus as claimed in any one of Claims 17 to 20, wherein the peripheral wall surface of the mould space is tapered inwardly of the mould space over at least a portion of its length, in the direction of plastics flow.

22. Apparatus as claimed in any one of Claims 17 to 21, including an extension overflow at the downstream end of the mould space.

23. Apparatus as claimed in Claim 22, wherein a gate leads to the extension overflow, and said gate is closable.

24. Apparatus as claimed in Claim 22 or Claim 23, wherein the overflow chamber is variable in volume.

25. Apparatus as claimed in Claim 24, wherein the overflow chamber is expandable by control means operable at a selected time in the moulding cycle.

26. Apparatus as claimed in Claim 24, wherein the overflow chamber is expandable by the plastics material entering the overflow chamber acting against spring pressure or hydraulic pressure.

27. An elongate member produced by a method as claimed in any one of Claims 1 to 16 or apparatus as claimed in any one of Claims 17 to 26.

28. An elongate member as claimed in Claim 27, wherein the elongate member is a blank for a golf club shaft, snooker cue, fishing rod or like member.

29. A golf club shaft comprising a moulded blank as claimed in Claim 28, and wrapping material or further wrapping material around at least part of its length including the end of the blank forming a handle portion.

30. A golf club shaft as claimed in Claim 29, wherein the wrapping material or further wrapping material comprises five layers.

31. A golf club comprising a golf club shaft as claimed in anyone of Claims 27 to 30, and a golf club head attached thereto.

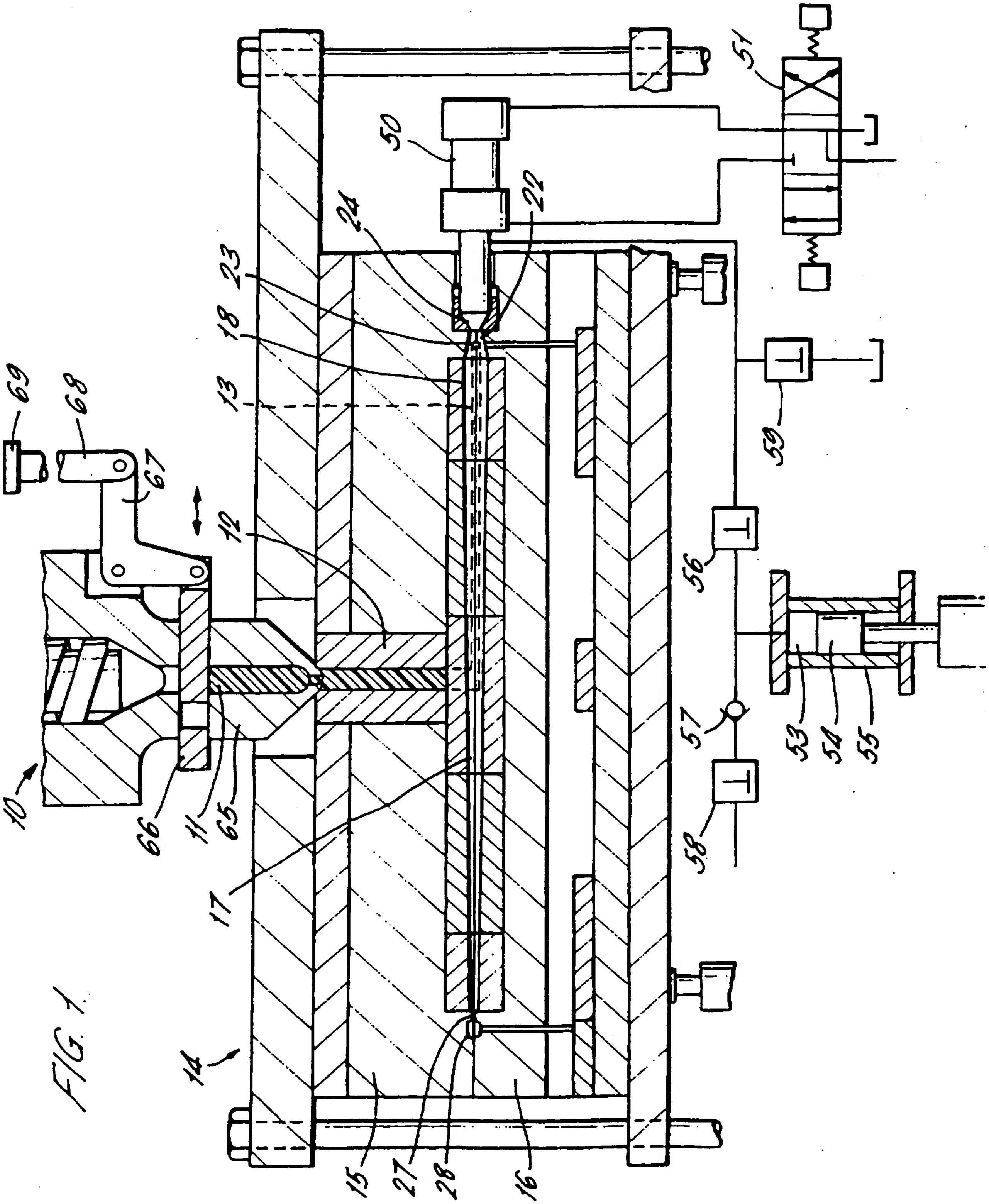
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FIG. 1.

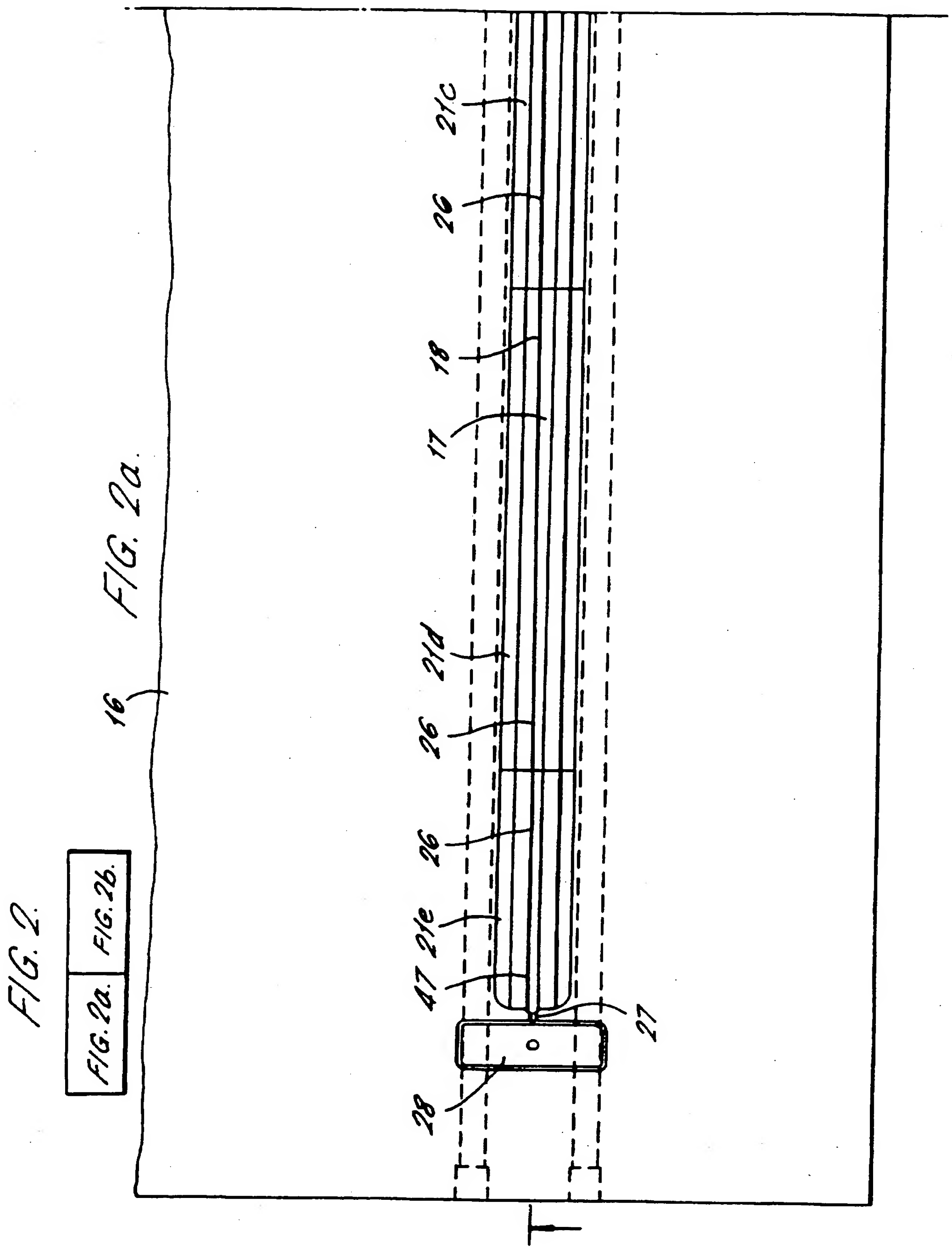
FIG. 2a.
16
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21d
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21e
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FIG. 2.
FIG. 2a.
FIG. 2b.

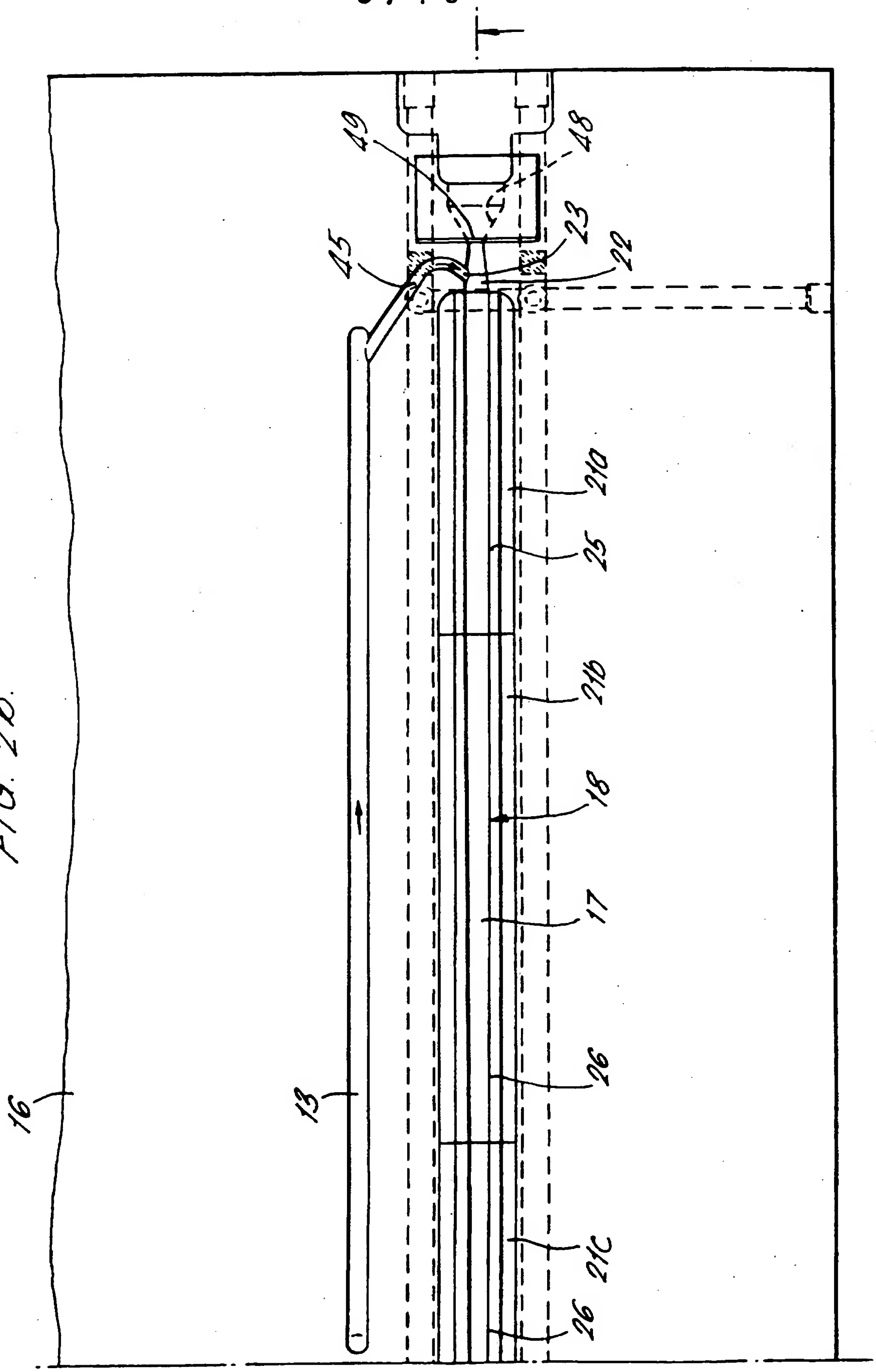


FIG. 2b

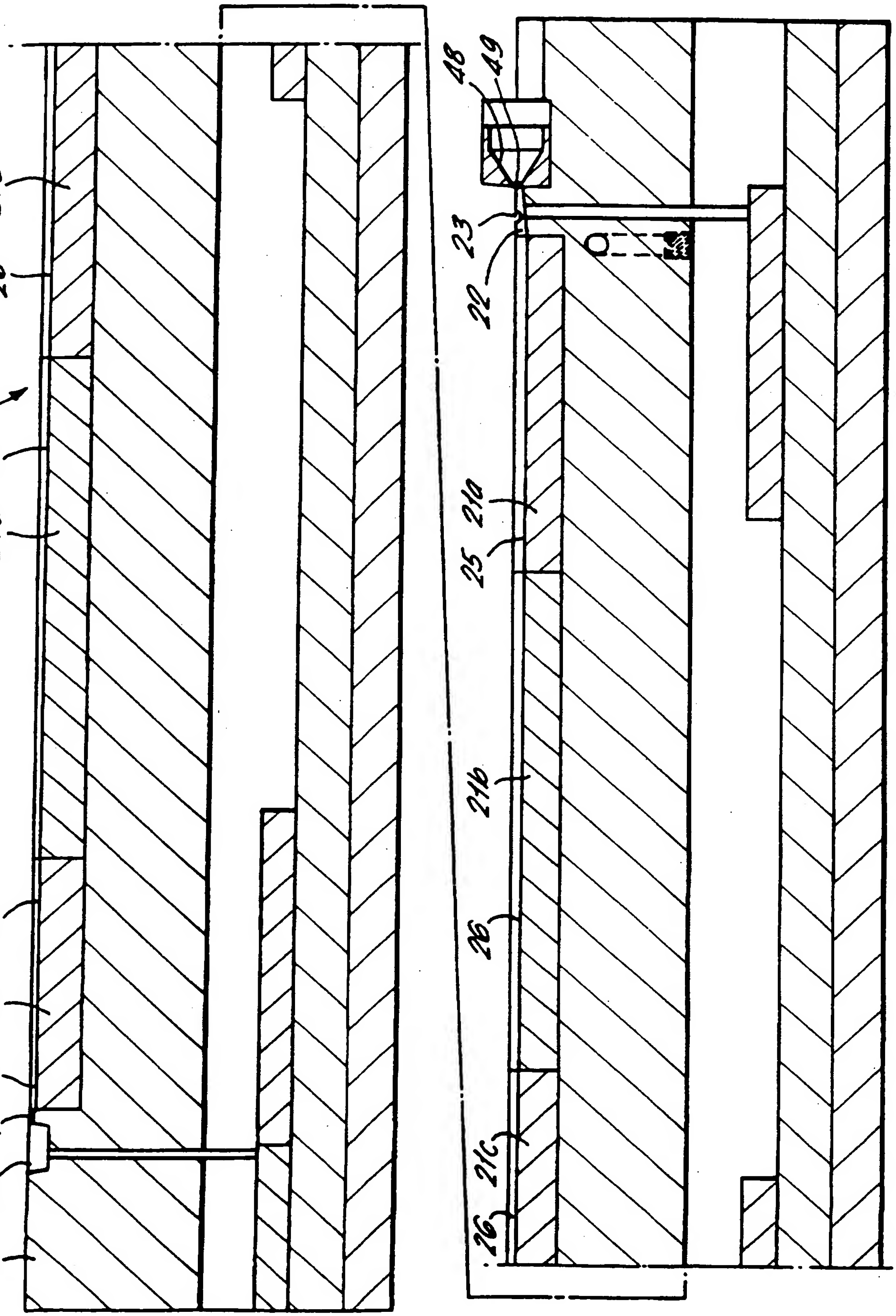
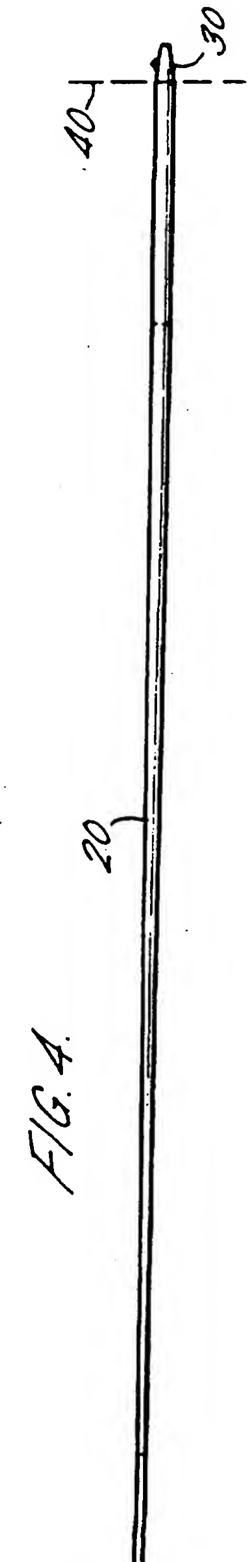


FIG. 3



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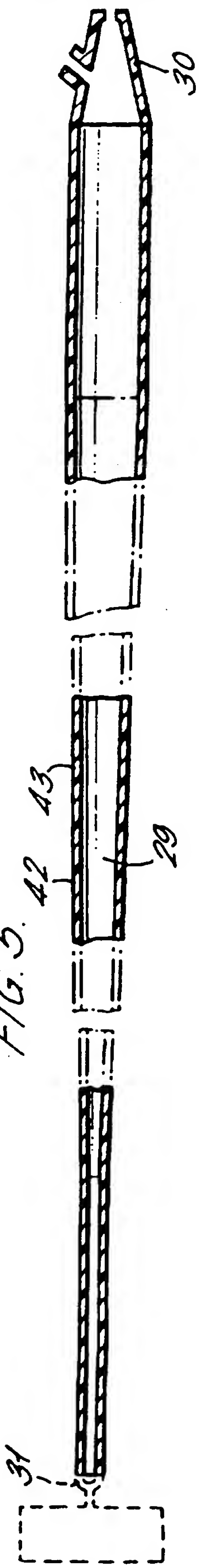

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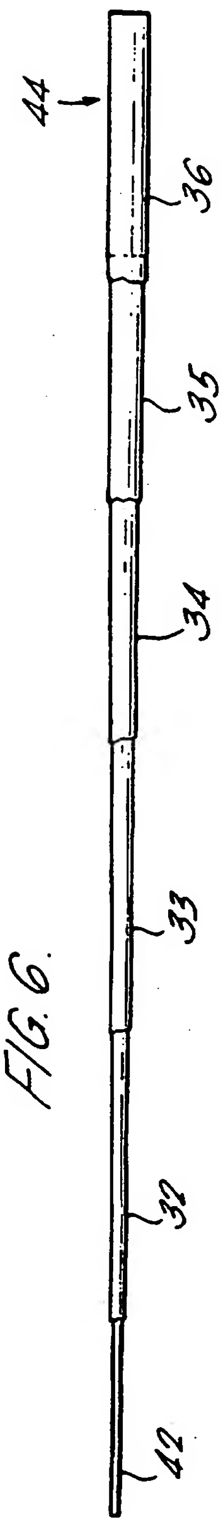
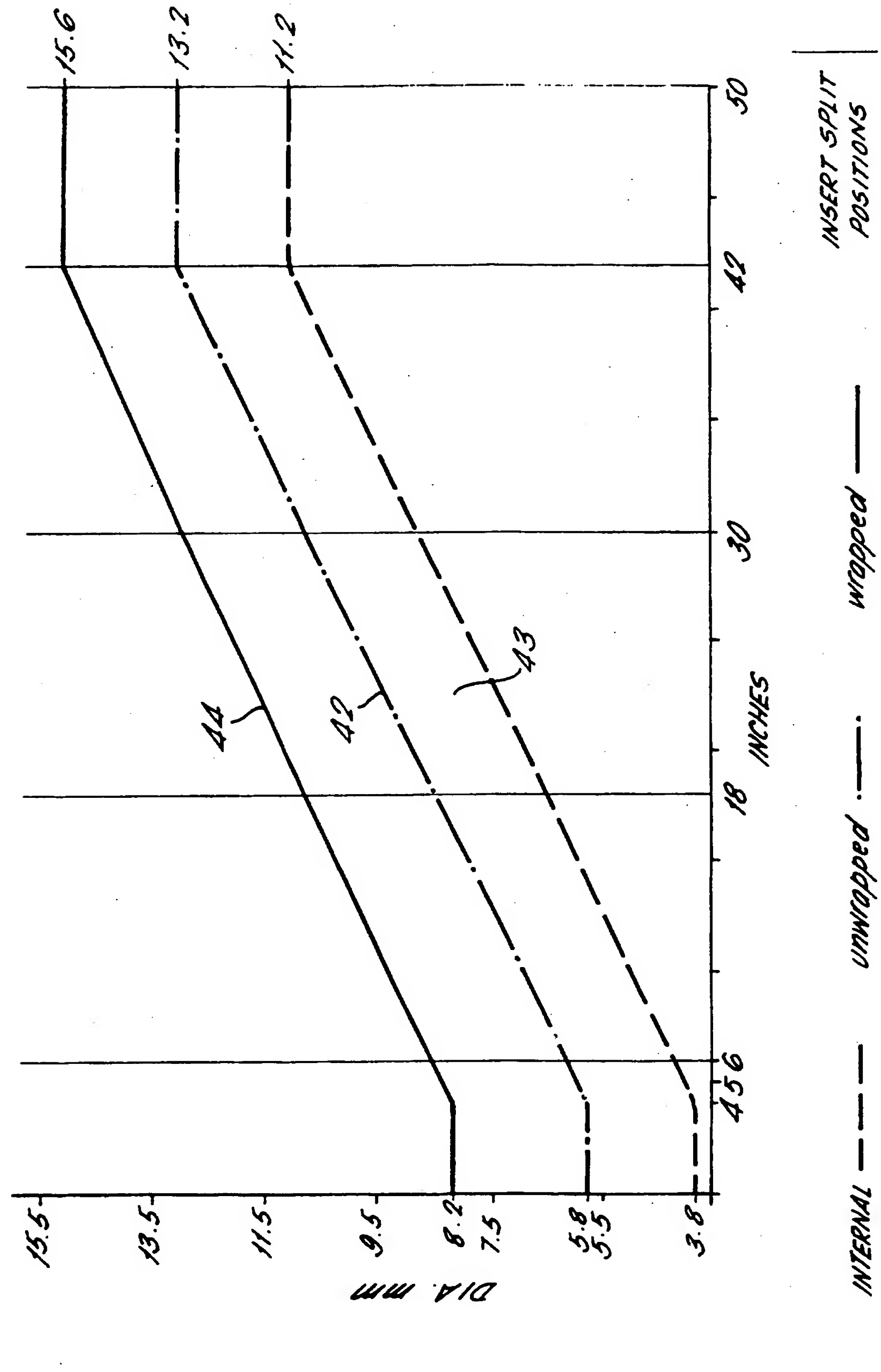


FIG. 6.

FIG. 7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13.2
11.2
50
42
30
18
4 5 6
INCHES
44
42
43
15.5
13.5
11.5
9.5
8.2
7.5
5.8
5.5
3.8
DIA. mm
INSERT SPLIT POSITIONS
INTERNAL
unwrapped
wrapped

FIG. 8.

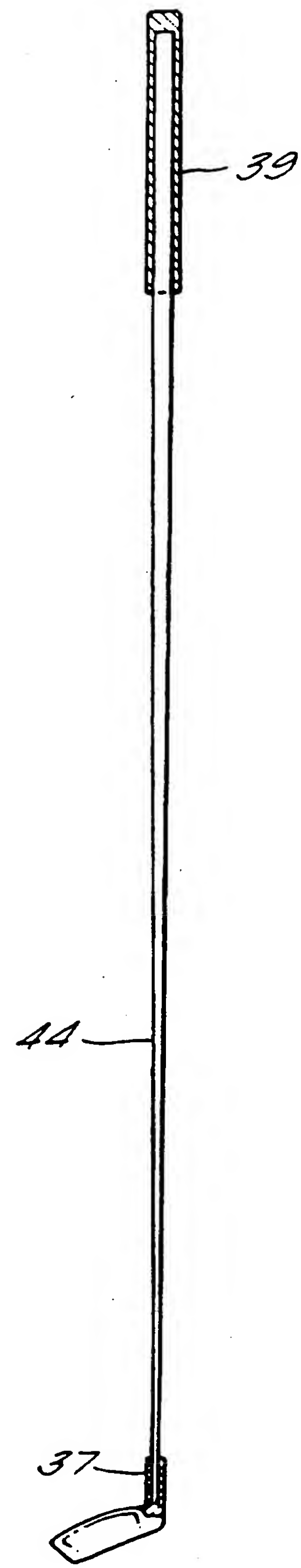


FIG. 9.

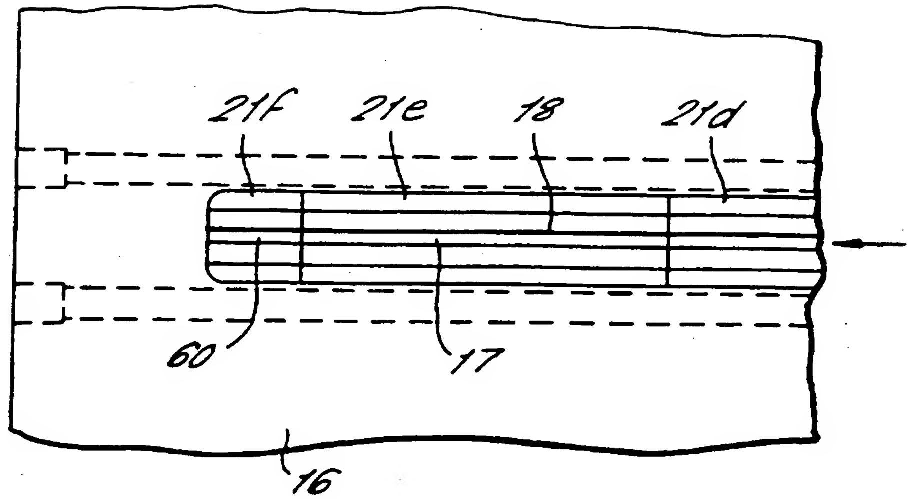


FIG. 10.

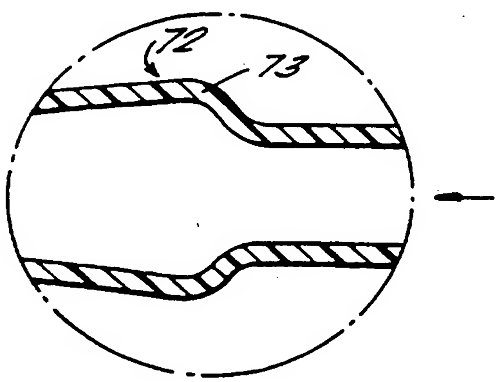


FIG. 11.

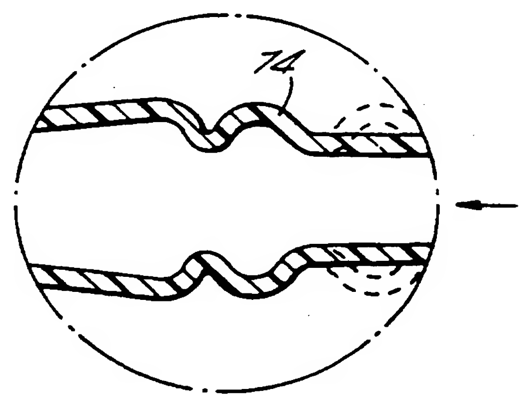


FIG. 12.

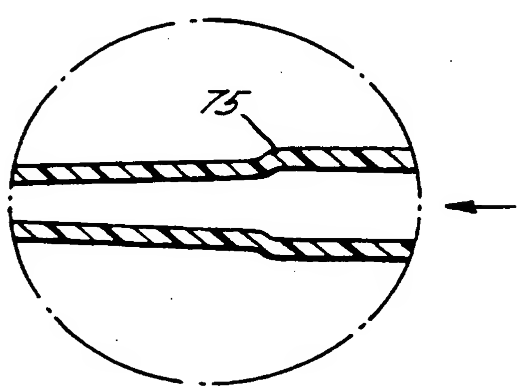


FIG. 13.

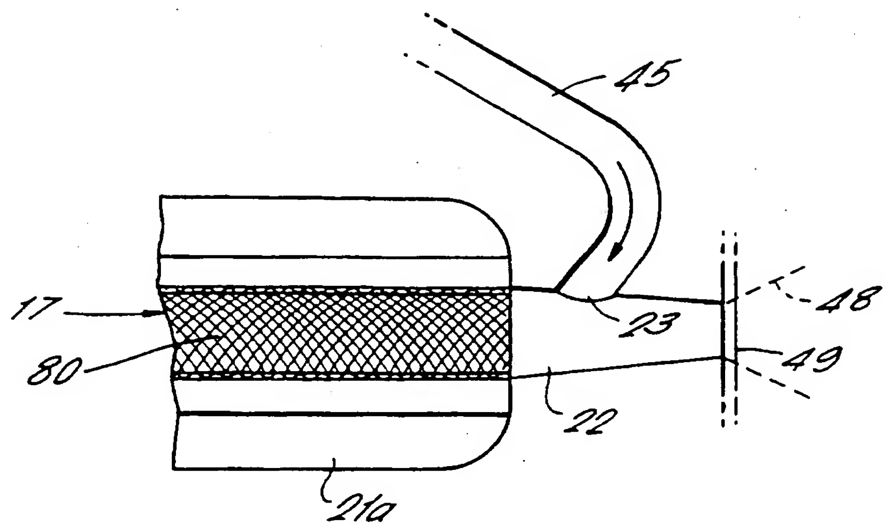


FIG. 14.

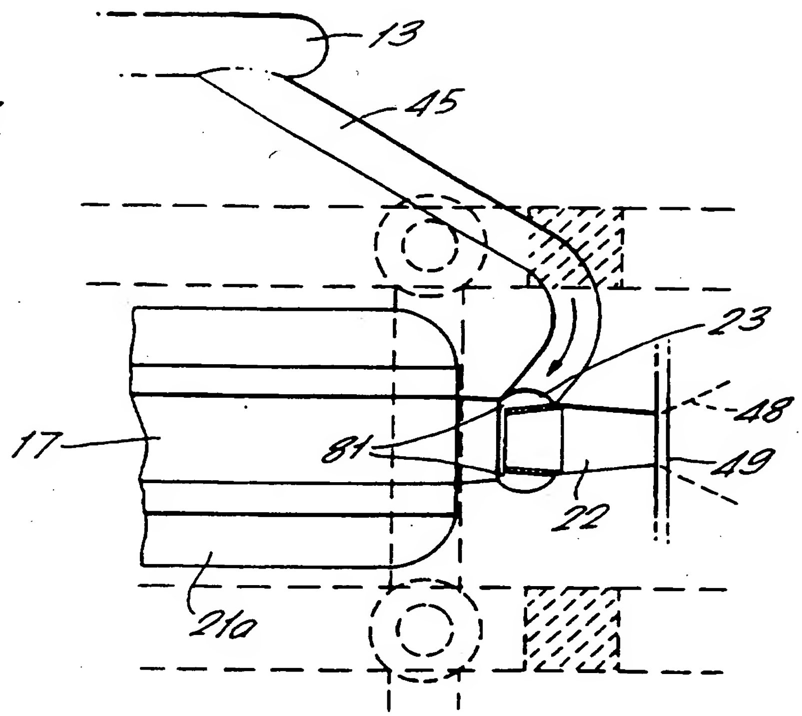
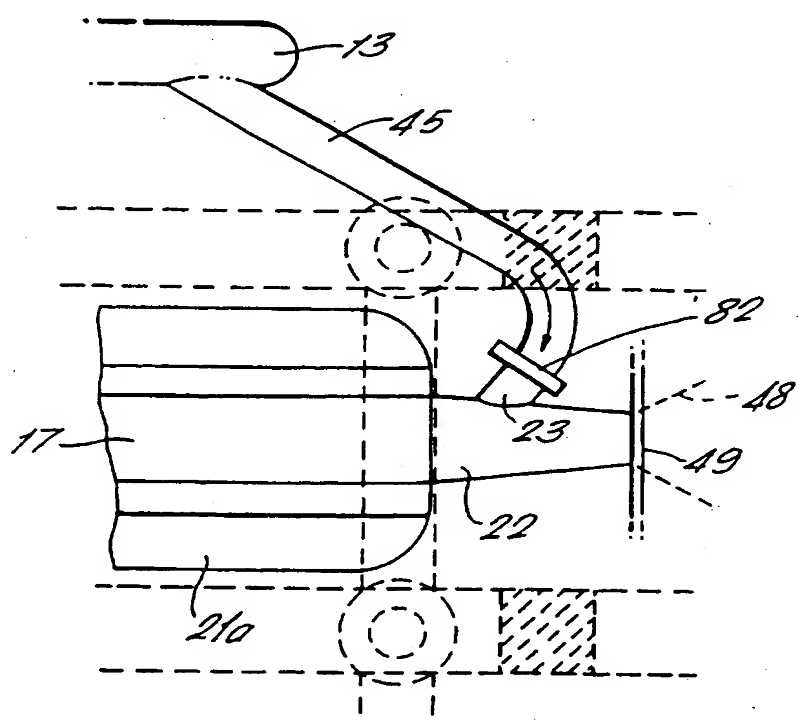


FIG. 15.



INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 97/01325

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C45/17 B29C45/00 B29C45/27 B29C70/86

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29C A63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 90 12679 A (SOLO GOLF LIMITED) 1 November 1990 see the whole document ---	1,4,6, 17,19, 27,28,31
P,A	PATENT ABSTRACTS OF JAPAN vol. 97, no. 3, 31 March 1997 & JP 08 289947 A (SUMITOMO RUBBER IND LTD), 5 November 1996, see abstract ---	1,4,17, 27,28
A	PATENT ABSTRACTS OF JAPAN vol. 95, no. 7, 31 August 1995 & JP 07 108562 A (AARU PII TOUPURA KK), 25 April 1995, see abstract --- -/--	1,4,7, 17,22, 23,27,28

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
7 August 1997	22.08.97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Bollen, J

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Inte. ..onal Application No
PCT/GB 97/01325

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0 438 279 A (KETER PLASTIC LTD) 24 July 1991 see the whole document ---	7,8, 22-24,26
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 4, 30 April 1996 & JP 07 323436 A (IDEMITSU PETROCHEM CO LTD), 12 December 1995, see abstract ---	7,22-26
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 636 (M-1715), 5 December 1994 & JP 06 246765 A (IDEMITSU PETROCHEM CO LTD), 6 September 1994, see abstract -----	7,22,23

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Information on patent family members

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